SMART VEHICLE DATA LOGGER USING GLOBAL POSITIONING SYSTEM AND GLOBAL SYSTEM FOR MOBILE COMMUNICATION

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I have declared “Smart Vehicle Data Logger using GPS and GSM interface” is the result of my own research except as cited in the references. This thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree

Signature: _____

Name: WAN MOHD AMIR HARIS BIN WAN SALLEHUDDIN

Date: 9 NOVEMBER 2008

Special dedicated to

my beloved parents and my brothers for guiding me in journey of education.

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ABSTRACT

Nowadays, there are lots of technologies growing in this world. Technologies such as Global Positioning System (GPS), Global System for Mobile communications (GSM) and Multimedia card (MMC) can make our lives more comfortable. The Smart Vehicle Data Logger can track speed and location of the vehicle travel using Global Positioning System (GPS) and store the information into Multimedia Card. User is allowed to trace the location of the vehicle by SMS the Data Logger. The system will send back the location of the vehicle through GSM module. The controller for this prototype design is microcontroller system using PIC 18F452 and programmed using PIC C Compiler (C Programming) software. So, with these technologies, we can create an excellent way for fleet owners and managers to monitor their cars, trucks, or vehicles efficiently.

ABSTRAK

Pada masa kini, pelbagai teknologi telah berkembang di dunia ini. Teknologi seperti “Global Positioning System (GPS), Global System for Mobile communications (GSM) dan Multimedia card (MMC)” membuatkan hidup kita lebih selesa. “Smart Vehicle Data Logger” ini boleh mengesan kelajuan dan lokasi kenderaan dan menyimpan data tersebut ke dalam “Multimedia kad”. Pengguna juga boleh mengesan lokasi kenderaan dengan menerusi perkhidmatan “SMS”. Sistem alat tersebut akan membalas kembali lokasi alat tersebut menerusi “GSM” sistem. Sistem pengawal untuk prototaip ini adalah mikro pengawal PIC18F452 dan ia diprogramkan menggunakan C program. Oleh itu, dengan adanya teknologi-teknologi ini, pengguna kenderaaan lebih mudah mengawal system kenderaan mereka.

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LIST OF ABBREVIATIONS

MCU	=	Microcontroller Unit
GPS	=	Global Positioning System
GSM	=	Global System for Mobile communications
MMC	=	Multimedia Card
SMS	=	Short Messaging System
I/0	=	Input / Output
V	=	Volts
LCD	=	Liquid Crystal Display
RAM	=	Random Access Memory
ROM	=	Read Only Memory
MHz	=	Megahertz
CS	=	Chip Select
s	=	second
SMS	=	Short Message System

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CHAPTER 1

INTRODUCTION

1.1 Project Overview

Nowadays, there are lots of technologies growing in this world. Technologies such as Global Positioning System (GPS), Global System for Mobile communications (GSM) and Multimedia card (MMC) make our lives more comfortable.

Global Positioning System (GPS): A typical GPS receiver calculates its position using the signals from four or more GPS satellites. Four satellites are needed since the process needs a very accurate local time, more accurate than any normal clock can provide, so the receiver internally solves for time as well as position. In other words, the receiver uses four measurements to solve for 4 variables - *x*, *y*, *z*, and *t*. These values are then turned into more user-friendly forms, such as latitude/longitude or location on a map, then displayed to the user.

Global System for Mobile communications (**GSM**) is the most popular standard for mobile phones in the world. GSM is used by over 2 billion people across more than 212 countries and territories. Its ubiquity makes international roaming very common between mobile phone operators, enabling subscribers to use their phones in many parts of the world.

The **MultiMediaCard** (**MMC**) is a flash memory card standard. MMC is used as storage media for a portable device, in a form that can easily be removed for access by a PC. For example, a digital camera would use an MMC for storing image files. With an MMC reader (typically a small box that connects via USB or some other serial connection, although some can be found integrated into the computer itself), a user could copy the pictures taken with the digital camera off to his or her computer. MMCs are currently available in sizes up to and including 4 GB with 8 GB models announced but not yet available.

As we all know, there are lots of car that produced by local company, but, customer cannot detect the vehicle's location. Customers also cannot log the history of the vehicle travel. So, a product had been design which uses all these technologies in order to make costumer more comfortable with the car.

1.2 Problem statement

As we all know, there are lots of vehicles that produced by local company. But, there are something not available yet:

1. Owners cannot trace their vehicle's location.
2. Owners also cannot log the history of the vehicle travel.

In order to these problem, a vehicle data logger will be design which can log the history of the vehicle travel and trace the vehicle's location.

1.3 Project Objective

The main objective of this project is to design a data logger that has ability to log data of a vehicle. There are three others objectives to be achieved beside the main objective stated above. The three objectives are discussed in the following paragraph.

First of all, design a controller that can read the data from GPS receiver and analysis the data till get the certain protocol only. The protocol that had been analyzed will show the time , longitude, latitude, date and speed of the receiver. To show all the data is valid or not, the four characteristics will be display to user.

The second objective is to store all the data that had been analyzed into a suitable storage. The storage must be large capacity because the data from GPS always receive at every second.

Last but not lease, to make the system is more friendly user , there will be a controller that can make two way communication between user and the system. With this system, user can track the vehicle either send a SMS or make a phone call to the system.

1.4 Project Scope

Few scopes and guidelines are listed to ensure the project is conducted within its intended boundary. This is to ensure the project is heading to the right direction to achieve its intended objectives.

The first scope is to design a controller that can control all the works in the system. The controller can read the GPS data, store the data into a storage card, display it at LCD and do transmit / receive to GSM module. In the other hand, the controller is the brain of the system.

Second scope of this project is to analysis the data from GPS receiver which can get the time , longitude, latitude, date and speed of the receiver. The data will be display at LCD Display.

The third scope is to store the data from GPS receiver into a Multimedia Card. All the time , longitude, latitude, date and speed of the GPS receiver will be store into MMC card through the microcontroller.

The last scope of this project is to trace the location of the vehicle using Global System for Mobile communications (GSM) *(two way communication between user and GSM Module)* and Global Positioning System (GPS).

1.5 Thesis Overview

This thesis consist of seven chapters. The first chapter will give an overview of the project as well as the objective of the project.

Chapter 2 covers the literature review or discuss about the research of the data logger current project and the component that will be used for this project. From this chapter, we can know all the protocol and characteristic of GPS Receiver, GPS Modem and MMC Configuration system.

Chapter 3 covers the electronic overview of the project. It describes the various modules developed, basic operation of each module. All five module are describe briefly in this chapter.

The elaboration of the software development will be discuss in Chapter 4. All the software used for this project will be describe briefly in this chapter.

The system implementation of the project will be discuss on Chapter 5. In this chapter, the software and hardware combination will be explained briefly. The hardware will be elaborates from the circuits and the programming of each modules will be discussed by using flow charts.

Chapter 6 explains the testing and result of each module. The result system effectiveness is also discussed.

Chapter 7 summarized the project outcome. A few suggestions are proposed to enhance the current design.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, we will discuss about the research of the data logger current project and the component that will be used for this project. From this literature review, we can get the idea of the function and description of the modules such as GPS module, GSM module and Multimedia card system.

This chapter is divided by two sections. One section is for current project and the another section is about the research of module use in this project. The sub section are listed as below :

i. Current Project
   - Shadow Tracker® Expert
   - CarChip Pro Automotive Data Logger

ii. Module research.
   - PIC18F452 Microchip Controller
   - Global Positioning System (GPS)
   - SanDisk MultiMediaCard and Reduced-Size MultiMediaCard
   - LCD module
   - GSM Module

2.2 Review of current project

In this project, a research had been done about the system that already exist that related in my project. There are two kind of product that had been create in order to log the data of the vehicle. There are :

i. Shadow Tracker® Expert
ii. CarChip Pro Automotive Data Logger

2.2.1 Shadow Tracker® Expert

The Shadow Tracker® Expert serves as protection for your company against employee time sheet fraud and unauthorized use of your vehicles. Using the latest Shadow Tracker® mapping software, the Shadow Tracker® Expert displays actual routes driven, number of stops, and amount of time spent at each site. [1]

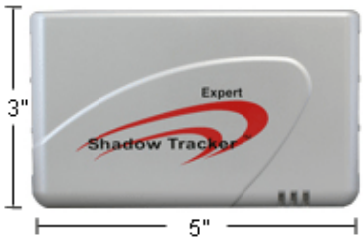

Figure 2.1 : Shadow Tracker® Expert

Features and Benefits :

i. USB connector with 921kbs download rate
ii. The 1MB of memory can store approximately 1851.9 hours of drive time*
iii. GPS antenna sensing and Ignition on/off sensing for detection of tampering
iv. Battery backup power off sensing
v. Down to 2 mph speed recording for slow moving tracking
vi. Optional rechargeable internal Lithium-Ion battery provides approximately 25 hours of tracking without main power
vii. Actively manage field personnel

viii. Know where your mobile workforce is every day
ix. Prevent incidents of employee time sheet fraud
x. Cut mobile fleet costs
xi. Head off customer service complaints
* Based on a 120 second collection rate of actual drive time

According to this product, it do not have two way communication using GSM. So, owner cannot trace the car on time.

2.2.2 CarChip Pro Automotive Data Logger

The Car Chip Pro Logger is capable of recording and logging driving, trip and engine performance data. By attaching the CarChip to your vehicle's On-board diagnostics (OBDII) port you get a detailed look at how the vehicle is driven, trip details, emissions status and engine diagnostic codes.[2]

Figure 2.2 : CarChip Pro Automotive Data Logger

CarChip Pro Logger Features :

i. Record up to 300 Hours of Trip Details
ii. Trip Details includes: Date/Time, Distance Traveled and Speed
iii. Provides Individual Graphs and Summary Reports
iv. Records Extreme Acceleration and Braking
v. Calculate Gas Mileage
vi. Includes Software and USB Cable

CarChip Pro Logger Specifications :

Table 2.1 : Carchip pro logger specification

Operating Temperature Range	-40°F to 185°F (-40°C to 85°C)
Primary Power (Connected to Vehicle)	9 to 16 VDC, 80 mA with Vehicle Running, 17mA with Vehicle's Power Off
Primary Power (Connected to Computer)	USB Powered
Backup Power	Internal Battery, Minimum of 5 Years Total, with Data Logger not Powered by Vehicle or Computer; 10-15 Year Life in Normal Use
Memory	512KB
Data Storage Capacity	300 Hours Maximum (Dependant on Interval and Environment)
Vehicle Interface	16-pin OBDII Connector
Alarm	Adjustable, Audible Alarm for Exceeding Speed, Acceleration, and Deceleration Limits
Supported OBDII Protocols	J1859-41.6, J1850-10.4, ISO9141, KWP2000 (ISO 14230), CAN (Control Area Network ISO 11898)
Vehicle Speed Sampling Interval	1, 5, 10, 30 or 60 Seconds
Dimensions	4.3" x 3.9 " x 0.78 " (109mm x 99mm x 20mm)
Weight	6oz. (169g)

According to this product, it cannot log the location of vehicle. It just can log the speed and the performance of engine of the vehicle. Otherwise, the data storage capacity is too small. Only 300 hours storage.

2.3 Research of project module

List of research :

- PIC18F452 Microchip Controller
- Global Positioning System (GPS)
- SanDisk MultiMediaCard and Reduced-Size MultiMediaCard

- LCD module
- GSM Module

2.3.1 PIC18F452 Microchip Controller

This powerful 10 MIPS (100 nanosecond instruction execution) yet easy-to-program (only 77 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 40- or 44-pin package and is upwards compatible with the PIC16C5X, PIC12CXXX, PIC16CXX and PIC17CXX devices and thus providing a seamless migration path of software code to higher levels of hardware integration. The PIC18F452 features a 'C' compiler friendly development environment, 256 bytes of EEPROM, Self-programming, an ICD, 2 capture/compare/PWM functions, 8 channels of 10-bit Analog-to-Digital (A/D) converter, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and Addressable Universal Asynchronous Receiver Transmitter (AUSART). All of these features make it ideal for manufacturing equipment, instrumentation and monitoring, data acquisition, power conditioning, environmental monitoring, telecom and consumer audio/video applications.[3]

Parameter Name	Value
Program Memory Type	Flash
Program Memory Size (Kbytes)	32
RAM	1,536
Data EEPROM (bytes)	256
I/O	34

Figure 2.3 : PIC18F452 Feature

2.3.2 Global Positioning System (GPS)

The GPS Receiver Module provides standard, raw NMEA0183 (National Marine Electronics Association) strings or specific user-requested data via the serial

command interface, tracking of up to 12 satellites, and WAAS/EGNOS (Wide Area Augmentation System/European Geostationary Navigation Overlay Service) functionality for more accurate positioning results.

The Module provides current time, date, latitude, longitude, altitude, speed, and travel direction/heading, among other data, and can be used in a wide variety of hobbyist and commercial applications, including navigation, tracking systems, mapping, fleet management, auto-pilot, and robotics. [4]

2.3.2.1 GPS Technology Brief

GPS (Global Positioning System) is a worldwide radio-navigation system formed by a constellation of 24 satellites and their ground stations. With an unobstructed, clear view of the sky, GPS works anywhere in the world, 24 hours a day, seven days a week.

The Global Positioning System consists of three interacting components:
1) The Space Segment -- satellites orbiting the earth.
2) The Control Segment -- the control and monitoring stations run by the United States Department of Defense (not discussed in this documentation).
3) The User Segment -- the GPS signal receivers owned by civilians and military.

The space segment consists of a constellation of 24 active satellites (and one or more in-orbit spares) orbiting the earth every 12 hours. Four satellites are located in each of six orbits and will be visible from any location on each 95 percent of the time. The orbits are distributed evenly around the earth, and are inclined 55 degrees from the equator. The satellites orbit at an altitude of about 11,000 nautical miles.

Each satellite transmits two signals: L1 (1575.42 MHz) and L2 (1227.60 MHz). The L1 signal is modulated with two pseudo-random noise signals - the protected (P) code, and the course/acquisition (C/A) code. The L2 signal only carries

the P code. Civilian navigation receivers only use the C/A code on the L1 frequency. Each signal from each satellite contains a repeating message, indicating the position and orbital parameters of itself and the other satellites (almanac), a bill of health for the satellites (health bit), and the precise atomic time.

The receiver measures the time required for the signal to travel from the satellite to the receiver, by knowing the time that the signal left the satellite, and observing the time it receives the signal, based on its internal clock. If the receiver had a perfect clock, exactly in sync with those on the satellites, three measurements, from three satellites, would be sufficient to determine position in three dimensions via triangulation. However, that is not the case, so a fourth satellite is needed to resolve the receiver clock error. With four satellites, a GPS receiver can provide very accurate clock (time, date) and position information (latitude, longitude, altitude, speed, travel direction/heading).

Note that position data and accuracy are affected or degraded by the satellite geometry, electromagnetic interference, and multipath, an unpredictable set of reflections and/or direct waves each with its own degree of attenuation and delay. Primarily due to satellite geometry, measuring altitude using GPS may introduce an accuracy error of 1.5 times the receiver's position accuracy (in the case of our GPS Receiver Module, this corresponds to about +/-20 meters in the vertical direction).

GPS signals work in the microwave radio band. They can pass through glass, but are absorbed by water molecules (wood, heavy foliage) and reflect off concrete, steel, and rock. This means that GPS units have trouble operating in rain forests, urban jungles, deep canyons, inside automobiles and boats, and in heavy snowfall - among other things. These environmental obstacles degrade positional accuracy or make it impossible to get a fix on your location.

Most GPS receivers output a stream of data so that it can be used and interpreted by other devices. The most common format (and used by our GPS Receiver Module in "Raw Mode") is NMEA0183 (National Marine Electronics

Association, http://www.nmea.org/), developed for data communications between marine instruments. Some receivers also have proprietary data formats which are used (in the case of navigation receivers) to transfer waypoint lists, track logs, and other data between the GPS and a computer. Such proprietary formats are not covered by the NMEA standard.

The NMEA0183 is provided as a series of comma-delimited ASCII strings, each preceded with an identifying header. The data is transmitted as a 4800bps string of 8-bit ASCII characters. Thus, any microcontroller with a serial port can extract data from a GPS module. But, modules do not produce "plain text" location information. Instead, they create standardized "sentences," such as:

$GPGGA,170834,4124.8963,N,08151.6838,W,1,05,1.5,280.2,M,-34.0,M,,*75
$GPGSA,A,3,19,28,14,18,27,22,31,39,,,,,1.7,1.0,1.3*34
$GPGSV,3,2,11,14,25,170,00,16,57,208,39,18,67,296,40,19,40,246,00*74
$GPRMC,220516,A,5133.82,N,00042.24,W,173.8,231.8,130694,004.2,W*70

Programmers can parse these strings to obtain their desired information, including time, date, latitude, longitude, speed, and altitude.

There are three standard notations for displaying longitude and latitude data:

- **GPS Coordinates** (degrees, minutes, and fractional minutes), ex: 36 degrees, 35.9159 minutes
- **DDMMSS** (degrees, minutes, seconds), ex: 36 degrees, 35 minutes, 55.3 seconds
- **Decimal Degrees**, ex: 36.5986 degrees

In “Smart Mode,” the Parallax GPS Receiver Module transmits latitude and longitude data to the user in GPS Coordinate format (degrees, minutes, and fractional minutes, see the “Communication Protocol” section for more details). Conversion to the two other notations, DDMMSS (degrees, minutes, second) and Decimal Degrees, is trivial and demonstrated in the example code below.

To graphically display your GPS position using Google Maps (in map, satellite, or hybrid view), simply go to http://maps.google.com/ and enter in your decimal coordinates in the "Search" field (for example, "36.5986, -118.0599" without the quotes).

To graphically display a track or series of waypoints, GPS Visualizer (http://www.gpsvisualizer.com/) is a free, easy-to-use online utility that creates maps and profiles from GPS data. GPS Visualizer can read data files from many different sources, including raw NMEA strings (such as those captured directly from the Parallax GPS Receiver Module in “Raw Mode”) or tab-delimited or comma-separated text of relevant GPS data.

2.3.2.2 GPS Electronic Connections

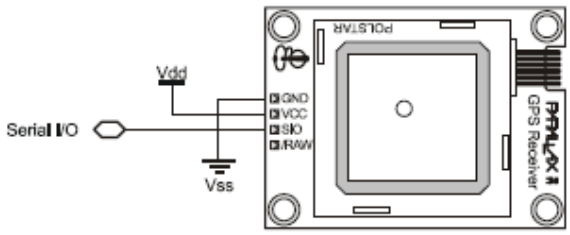

Figure 2.4 : GPS Module

Table 2.2 : GPS Electronic Description

Pin	Pin Name	Type	Function
1	GND	G	System ground. Connect to power supply’s ground (GND) terminal.
2	VCC	P	System power, +5V DC input.
3	SIO	I/O	Serial communication (commands sent TO the Module and data received FROM the Module). Asynchronous, TTL-level interface, 4800bps, 8 data bits, no parity, 1 stop bit, non-inverted.

4	/RAW	I	Mode select pin. Active LOW digital input. Internally pulled HIGH by default. When the /RAW pin is unconnected, the default "Smart Mode" is enabled, wherein commands for specific GPS data can be requested and the results will be returned (see the "Command Structure" section for more details). When /RAW is pulled LOW, the Module will enter "Raw Mode" and will transmit standard strings, allowing advanced users to use the raw GPS data directly.

2.3.2.3 GPS Status Indicators

The GPS Receiver Module contains a single red LED (light-emitting diode) to denote system status. The LED is located in the lower-right corner of the Module. A white overlay on the Module's printed circuit board is used to reflect the light from the LED, making it easier for the user to see. The LED denotes two states of the Module:

1) **Blinking** (both fast and slow): Searching for satellites or no satellite fix acquired

2) **Solid**: Satellites successfully acquired (a minimum of three satellites is required before the Module will begin to transmit valid GPS data)

Upon power up of the GPS Receiver Module in a new location, the Module may take up to five minutes or more to acquire a fix on the necessary minimum number of four satellites. During this time, the red LED on the Module will blink. When enough satellites are acquired for the Module to function properly, the red LED will remain solid red. Due to a variety of conditions, the number of satellites may vary at any given time. If the LED is OFF, there may be a problem. Please check your wiring and configuration of the Module.

2.3.2.4 GPS Mode Selection

The /RAW pin allows user selection of the GPS Receiver Module's two operating modes:

- **Smart Mode:** When the /RAW pin is pulled HIGH or simply left unconnected (the pin is internally pulled HIGH), the default "Smart Mode" is enabled, wherein commands for specific GPS data can be requested and the results will be returned. See the "Communication Protocol" section for more details.

- **Raw Mode:** When the /RAW pin is pulled LOW, "Raw Mode" is enabled in which the Module will transmit standard NMEA0183 v2.2 strings (GGA, GSV, GSA, and RMC), allowing advanced users to use the raw GPS data directly. For more information on NMEA0183 data, see the "GPS Technology Brief" section.

In either mode, data is transmitted at 4800bps, 8 data bits, no parity, 1 stop bit, non-inverted, TTL-level.

2.3.2.5 GPS Electrical Characteristics

Absolute Maximum Ratings

Table 2.3 : GPS Electrical Characteristic

Condition	Value
Operating Temperature	-40ºC to +85ºC
Storage Temperature	-55ºC to +100ºC
Supply Voltage (V_{CC})	+4.5V to +5.5V
Ground Voltage (V_{SS})	0V
Voltage on any pin with respect to V_{SS}	-0.6V to +(Vcc+0.6)V

2.3.3 SanDisk MultiMediaCard and Reduced-Size MultiMediaCard

2.3.3.1 Introduction

The SanDisk MultiMediaCard and Reduced-Size MultiMediaCard (RS-MMC) are very small, removable flash storage devices, designed specifically for storage applications that put a premium on small form factor, low power and low cost. Flash is the ideal storage medium for portable, battery-powered devices. It features low power consumption and is non-volatile, requiring no power to maintain the stored data. It also has a wide operating range for temperature, shock and vibration.

The MultiMediaCard and RS-MultiMediaCard are well suited to meet the needs of small, low power, electronic devices. With form factors of 32 mm x 24 mm and 1.4 mm thick for the MultiMediaCard and 18 mm x 24 mm x1.4 mm for the RS-MultiMediaCard, these cards can be used in a wide variety of portable devices like mobile phones, and voicerecorders.

To support this wide range of applications, the MultiMediaCard Protocol, a simple sevenpinserial interface, is designed for maximum scalability and configurability. All device andinterface configuration data (such as maximum frequency, card identification, etc.) are stored on the card.

The SanDisk MultiMediaCard/RS-MultiMediaCard interface allows for easy integration into any design, regardless of microprocessor used. For compatibility with existing controllers, the card offers, in addition to the card interface, an alternate communication protocol, which is based on the Serial Peripheral Interface (SPI) standard.

The MultiMediaCard/RS-MultiMediaCard provides up to 256 million bytes of memory using SanDisk Flash memory chips, which were designed by SanDisk especially for use in mass storage applications. In addition to the mass storage

specific flash memory chip, the MultiMediaCard/RS-MultiMediaCard includes an on-card intelligent controller which manages interface protocols and data storage and retrieval, as well as Error Correction Code (ECC) algorithms, defect handling and diagnostics, power management and clock control.

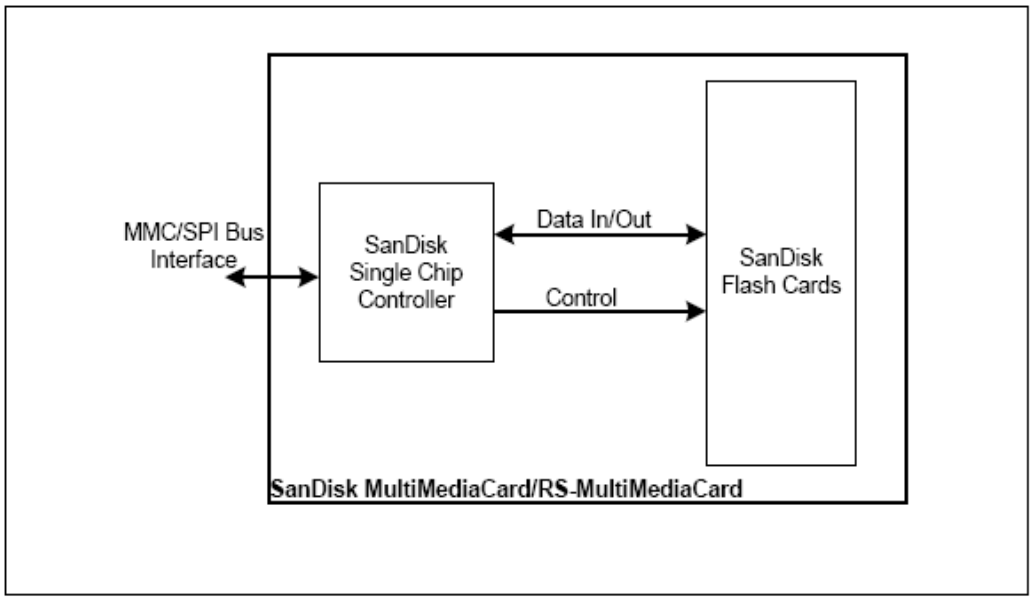

Figure 2.5 : Multimedia Card Block Diagram

2.3.3.2 MMC Features

The SanDisk MultiMediaCard/RS-MultiMediaCard features include:

i. MultiMediaCard Protocol compatible
ii. SPI Mode supported
iii. Targeted for portable and stationary applications
iv. Voltage range
    a. Basic communication: 2.7 to 3.6 V
    b. Memory access: 2.7 to 3.6 V
v. Maximum data rate with up to 10 cards
vi. Correction of memory field errors
vii. Variable clock rate 0 - 20 Mhz
viii. Multiple cards stackable on a single physical bus

2.3.3.3 MMC Functional Description

The MultiMediaCard and RS-MultiMediaCard contain a high level, intelligent subsystem as shown by the block diagram in Figure 1-1. This intelligent (microprocessor) subsystem provides many capabilities not found in other types of memory cards. These capabilities include:

• Host independence from details of erasing and programming flash memory
• Sophisticated system for managing defects (analogous to systems found in magnetic
disk drives)
• Sophisticated system for error recovery including a powerful error correction code
• Power management for low power operation

2.3.3.4 Flash-Independent Technology

The 512-byte sector size of the MultiMediaCard and RS-MultiMediaCard is the same as that in an IDE magnetic disk drive. To write or read a sector (or multiple sectors), the host computer software simply issues a read or write command to the card. This command contains the address. The host software then waits for the command to complete. The host software does not get involved in the details of how the flash memory is erased, programmed or read. This is extremely important as flash devices are expected to get more and more complex in the future. Because the MultiMediaCard and RS-MultiMediaCard uses an intelligent on-board controller, the host system software will not require changing as new flash memory evolves. In other words, systems that support the SanDisk MultiMediaCard/RS-MultiMediaCard today will be able to access future cards built with new flash technology without having to update or change host software.

2.3.4 LCD module

Liquid crystal display (LCD) is another common output device. There are various type and model of LCD available in market. The type of JHD 162A LCD will be used in this project. The role of LCD here will display the user information such as username, time and date.

Some features of LCD are:

- 16 character x 2 row
- 7 x 5 dots
- Reflective with EL and LED backlight
- LED/4.2 VDC

LCD is divided into two register bits which are Control Register and Data Register. The Control Register is used to control the operation of LCD while the data register is used to display the character. The figure 2.6 show the LCD display device.

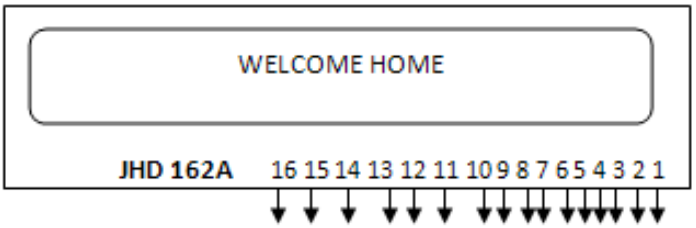

Figure 2.6 : LCD Display

2.3.5 GSM Module

2.3.5.1 Introduction

This part describes the hardware of TMAS GSM/GPRS Terminal. The information is intended for users or developers who design and build wireless cellular, M2M or other data telemetry applications. The scope of this part includes

interface specifications, mechanical characteristics of TMAS GSM/GPRS Terminal and power supply issues. TMAS GSM/GPRS Terminal is a compact GSM modem terminal for the transfer of data, SMS and faxes in the GSM networks. Cinterion/Siemens MC52i/MC55i/MC39i/TC35i GSM engine is embedded to provide good quality and reliability of data transfer. Terminal design is also based the industrial standard interfaces and an integrated SIM card reader to allow ease of use to the users.[6]

Module benefit :

i. Low cost
ii. CE Certified, Reliable and Quality with approved GSM/GPRS modules from Cinterion (a.k.a. Siemens)
iii. Non Proprietary Accessories, i.e. standard power adapter and standard modem cable
iv. (You can have the option to purchase these standard accessories in your country or from TCAM or from any cheaper source)
v. Compact and nice stylish silver casing
vi. Flexible mounting: Rail fixing or side mounting plates.

2.3.5.2 GSM Interface Description

TMAS GSM/GPRS Terminal provides the following connectors for power supply, interfacing and antenna:

• 2.1mm DC power connector (center/inner pin is positive)
• 9-pin (female) D-SUB plug for RS-232 serial interface
• SMA connector for antenna (radio interface)
• SIM card holder

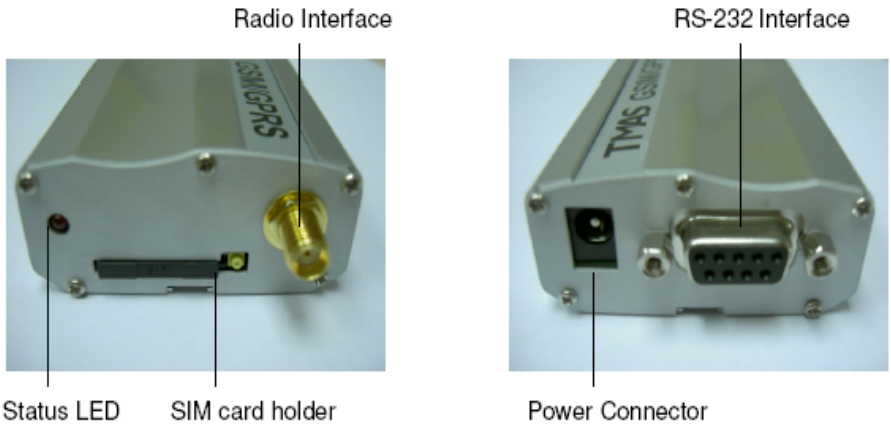

Figure 2.7: GSM Interface

2.3.5.3 GSM Operating Modes

The table below briefly summarizes the various operating modes of TMAS GSM/GPRS Terminal.

Table 2.4: GSM Operating Mode

Mode	Function
SLEEP	Various power saving modes set by AT+CFUN command. Software is active to minimum extent. If the Terminal was registered to the GSM network in IDLE mode, it remains, in SLEEP mode, registered and pageable from the BTS. Power saving can be chosen at different levels. The NON-CYCLIC SLEEP mode (AT+CFUN=0) disables the AT interface. The CYCLIC SLEEP mode AT+CFUN=5, 6, 7 and 8 alternatively activate and deactivate the AT interface to allow permanent access to all AT commands.
GSM IDLE	Software is active. Once registered to the GSM network, paging with BTS is carried out. The Terminal is ready to send and receive.
GSM TALK	Connection between two subscribers is in progress. Power consumption depends on network coverage individual settings, such as DTX off/on, FR/EFR/HR, hopping sequences, antenna.
GPRS IDLE	Module is ready for GPRS data transfer, but no data is currently sent or received. Power consumption depends on network settings and GPRS configuration (e.g. DRX settings).
GPRS DATA	GPRS data transfer in progress. Power consumption depends on network settings (e.g. power control level), uplink / downlink data rates and GPRS configuration (e.g. used multi-slot settings).

2.3.5.4 GSM RS-232 Interface

Via RS-232 interface, the host controller controls the TMAS GSM/GPRS Terminal and transports data. The figure below shows the pin assignment of RS-232 (D-SUB 9-pin female).

Figure 2.8 : GSM RS232 interface

The table below illustrates pin assignment of 9-pole D-SUB (female) RS-232.

Table 2.5 : GSM Rs232 Pin Assignment

Pin no.	Signal name	I/O	Function
1	/DCD	O	Data Carrier Detected
2	/RXD	O	Receive Data
3	/TXD	I	Transmit Data
4	/DTR	I	Data Terminal Ready
5	GND	-	Ground
6	/DSR	O	Data Set Ready
7	/RTS	I	Request To Send
8	/CTS	O	Clear To Send
9	/RI	O	Ring Indication

• Pin TxD @ application sends data to TxD of TMAS GSM/GPRS Terminal

• Pin RxD @ application receives data from RxD of TMAS GSM/GPRS Terminal

The RS-232 interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T V.24 Interchange Circuits DCE. It is configured for 8 data bits, no parity and 1 stop bit, and can be operated at bit rates from 300bps to 115Kbps. Autobauding supports bit rates from 4.8Kbps to 115Kbps. Hardware handshake using the /RTS and /CTS signals and XON/XOFF software flow control are supported. In addition, the modem control signals /DTR, /DSR, /DCD and /RING are available. The modem control signal RING (Ring Indication) can be used to indicate to the cellular device application, that a call or Unsolicited Result Code (URC) is received. There are different modes of operation, which can be set with AT commands.

2.3.5.5 SIM Interface

The SIM interface is intended for 3V SIM cards in accordance with GSM 11.12 Phase 2. The card holder is a 5- wire interface according to GSM 11.11. A sixth pin has been added to detect whether or not a SIM card is inserted.

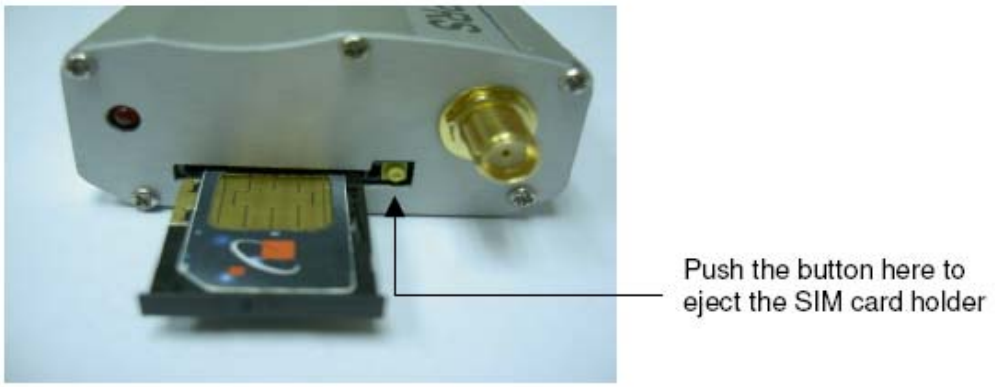

Figure 2.9 : SIM Interface